

System Performance Testing of the DSN Radio Science System, Mark III-78

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System Performance Tests are required to evaluate system performance following initial system implementation and subsequent modification, and to validate system performance prior to actual operational usage. This article describes non-real-time end-to-end Radio Science system performance tests that are based on the comparison of open-loop radio science data to equivalent closed-loop radio metric data, as well as an abbreviated Radio Science real-time system performance test that validates critical Radio Science System elements at the Deep Space Station prior to actual operational usage.

I. Introduction

Radio Science data generated by the DSN Radio Science System are conveniently categorized as follows:

- (1) Closed-loop radio metric data generated via the DSS Tracking Subsystem.
- (2) Open-loop radio science data generated via the DSS Radio Science Subsystem (64-m subnet only).

System performance tests already exist for the closed-loop radio metric data generation system, so that the primary thrust of Radio Science system performance tests (SPTs) will be the verification and evaluation of the open-loop data generation paths. SPTs can be considered to have two primary functions, as follows:

- (1) In-depth evaluation of system capabilities and performance following initial system implementation and significant system modification. Successful completion of SPTs allows system transfer to DSN operations for project usage.
- (2) Routine validation of system performance prior to actual operational usage.

To satisfy the above functions, two conceptually distinct SPTs will be developed, as follows:

- (1) An end-to-end Radio Science SPT which includes elements located within the Deep Space Stations (DSSs), the Ground Control Facility (GCF), and the Network Operations Control Center (NOCC). This test will be performed in non-real-time.

- (2) An abbreviated Radio Science SPT which will include only the critical elements at the DSS, and will be performed in real-time prior to actual radio science operations.

These tests will be detailed in Sections II and III to follow.

II. End-to-End Radio Science System Performance Tests

Open-loop radio science data is generated via two independent paths identified as follows:

- (1) Real-time bandwidth reduction.
- (2) Wideband recording.

Although the two processes utilize very different equipment and techniques, both have similar inputs and outputs:

- (1) Input — Spacecraft signal acquired by an open-loop receiver.
- (2) Output — A digitized recording of a narrow frequency bandwidth which contains the actual spacecraft frequency mixed with the predicted spacecraft frequency, and a numerical representation of the predicted spacecraft frequency.

It is thus apparent that to thoroughly perform an end-to-end test of the Radio Science System, two separate tests will be required. The tests will be conceptually similar; however, the assemblies and subsystems that actually compose the two separate data acquisition paths will be quite dissimilar.

The basic approach utilized to implement a Radio Science System end-to-end SPT is rather novel — the final (open-loop) radio science deliverable to the project (bandwidth reduced frequency data) will be compared to the equivalent (closed-loop) radio metric deliverable to the project (doppler data). This test will be quite flexible in that it can be performed routinely when tracking any spacecraft, and further allows any desired downlink frequency signature to be approximated via the use of uplink ramping (one round-trip-light-time earlier).

The inputs to the system performance test software that will perform the radio science data-radio metric data comparison are the radio science data (real-time bandwidth reduction) Intermediate Data Record (IDR), the wideband radio science data (wideband recording) IDR, and the radio metric IDR. The DSN elements exercised in the generation of a radio science data IDR are:

- (1) Narrowband Open-Loop Receiver (OLR)
- (2) Programmed Oscillator Control Assembly (POCA)
- (3) Programmed Oscillator (PO)
- (4) Occultation Data Assembly (ODA)
- (5) POEAS Software Program
- (6) PREDIK Software Program
- (7) High Speed Data transmission (HSD)
- (8) Data Records Subsystem (GDR)

In generation of a wideband radio science IDR they are:

- (1) Wideband Open-loop Receiver (OLR)
- (2) Digital Recording Assembly (DRA)
- (3) PREDIK Software Program
- (4) CTA 21 Radio Science Subsystem (CRS)
- (5) High Speed Data Transmission (HSD).

Figure 1 provides the functional block diagram for the real-time bandwidth reduction SPT, while Fig. 2 provides the functional block diagram for the wideband recording SPT.

Radio Science System performance evaluation and acceptance criteria in conjunction with these tests will be based on:

- (1) Absolute differences in 1 second averaged frequencies.
- (2) RMS differences over various time scales of 1 second averaged frequencies.

III. Abbreviated Radio Science System Performance Test

The critical elements which require checkout prior to actual operational usage of the real-time bandwidth reduction capability are:

- (1) Open-loop receiver (OLR)
- (2) Programmed Oscillator Control Assembly (POCA)
- (3) Programmed Oscillator (PO)

(4) Spectral Signal Indicator (SSI)

(5) Occultation Data Assembly (ODA).

Figure 3 illustrates a very simple configuration that will adequately validate real-time bandwidth reduction capability (in concert with the available Occultation Data Assembly internal software tests). Essentially, the initial frequency of a given predict set provides the POCA-PO driver; at the same time, the corresponding S- and X-Band frequencies from the test translator are input to the narrowband OLR. The OLR output is recorded by the ODA and displayed on the SSI; acceptance criteria are simply that the ODA recorded signals be centered in the SSI (displayed) bandpass. Additionally, the ODA recorded signals will be included in the IDR delivered to the project and may find use as a system calibration.

A corresponding abbreviated SPT for wideband recording capability is not required, as the three critical elements:

(1) Open-loop receiver (OLR)

(2) Digital Recording Assembly (DRA)

(3) CTA 21 Radio Science Subsystem (CRS)

function independently of each other, and hence existing individual assembly and subsystem level tests should suffice.

IV. System Performance Test Development Schedule

The planned schedule for availability of the various Radio Science SPTs is as follows:

(1) End-to-end wideband recording SPT — April 1, 1978.

(2) End-to-end real-time bandwidth reduction SPT — July 1, 1978.

(3) Abbreviated real-time bandwidth reduction SPT — July 1, 1978.

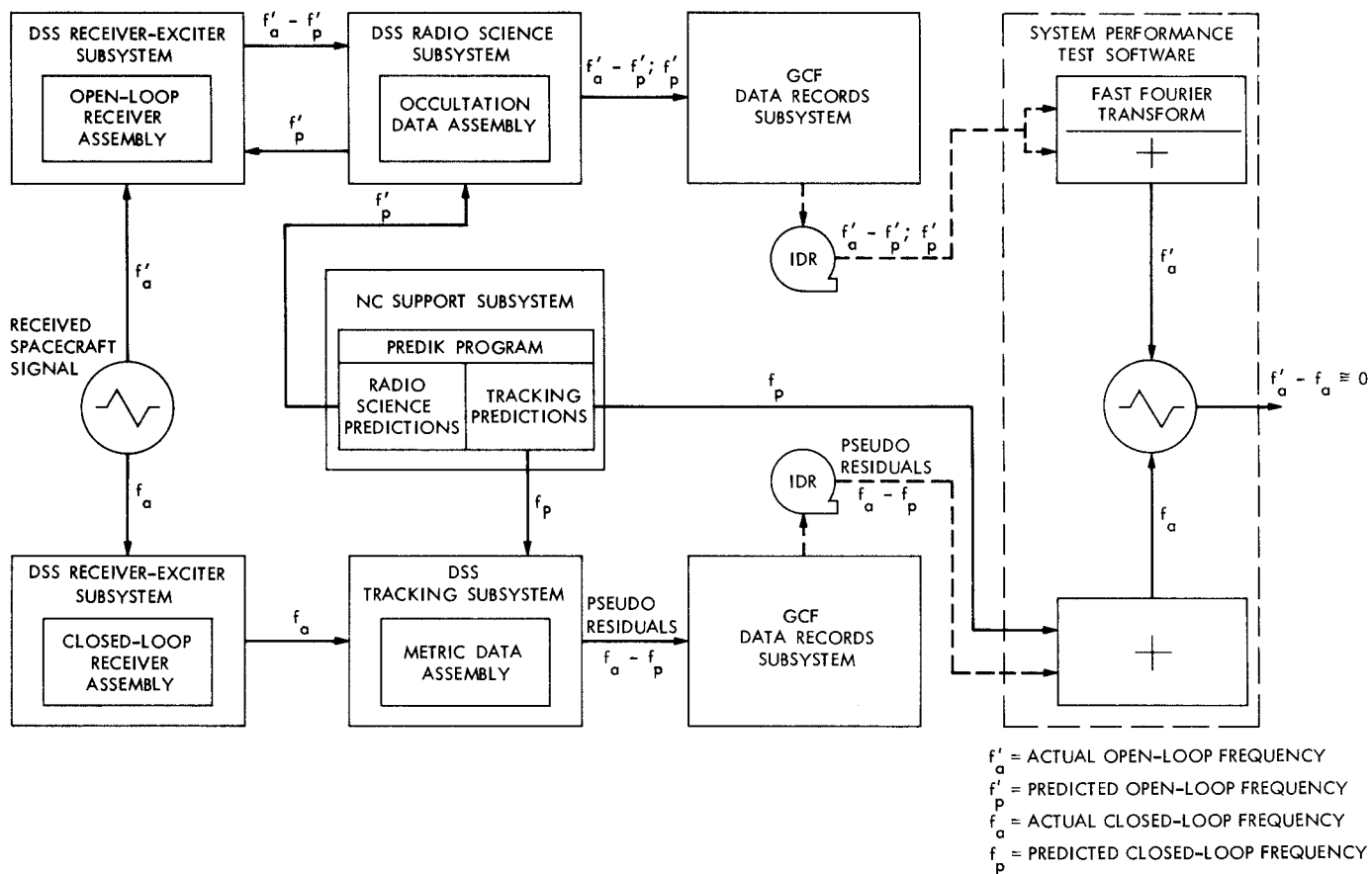


Fig. 1. DSN Radio Science system performance test of real-time bandwidth reduction capability

